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THE WILLOW-WRENS OF A LOTHIAN WOOD.

(WITH MAP SHOWING POSITION OF NESTS IN 1910.)

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Description of Wood.—The plantation with which the following remarks deal is situated in the north-east of Linlithgowshire, within a mile of the Midlothian border. It lies at an altitude of rather less than 200 ft., is 25·999 acres in area, and is of very mixed growth. Briefly described, the south and north-west sections consist of thickly planted Scots-fir and spruce of considerable age, shading the ground so closely that undergrowth hardly survives except round the outskirts. The central and eastern portions—which together include the larger part of the whole wood—contain an irregular growth of young Scots-fir and larch, chiefly the former, averaging 12–15 ft. in height. Round the edge of the wood is a broad border of well-grown trees of various species—elm, ash, oak, Spanish chestnut, &c.—together with such bushes as elder and guelder-rose. To the north the wood ends in a long narrow strip, mainly deciduous in growth. A wide ride runs round the outer edge ; a narrower one extends north and south through the centre ; while a small burn flows through from west to east. Main features of the undergrowth are clumps of ferns of three species (*Athyrium filix-fœmina*, *Lastræa filix-mas*, and *L. dilatata*), and, in the more open parts, clumps of *Phalaris arundinacea*—beloved of Whitethroats—and beds of rose-bay (*Epilobium angustifolium*).

The fact that open spaces are scarce except in the vicinity of the rides must be taken into account in considering the positions of the nests.

Methods of Arrival and Departure.—In the case of the Willow-Wren, as in most of our summer migrants, the male birds reach the breeding-grounds in advance of the females. In this district the first arrivals usually show themselves during the third week in April, the average date being about the 19th of that month. The filling-up of the area takes time, and is seldom complete—even as regards the males—until May is in. The arrival of the females commences about a fortnight after that of the earliest males, and appears to extend, as a rule, over a shorter space of time. In a favourable season the whole migration of both sexes may be complete in about three weeks, but in a broken spring this is otherwise. For example, in 1910, which had a particularly barren April, with an unusual prevalence of strong cold north-west winds, the arrival of Willow-Wrens was exceptionally irregular and protracted. Thus, while the first males reached the wood on April 21st, only a third of the whole had settled down by the end of the month, and the population did not approach completion until May 8th–9th (there was evidence elsewhere of males continuing to arrive as late as May 20th). A close watch for females revealed none before May 15th, and the bulk of them arrived with a rush between that date and the 18th. A table may make this arrival clearer :—

Date.	Wind.	Male birds present in wood.
April 20	W. light	—
,, 21	N.W. strong	3
,, 22	W. light	3
,, 23	W. very strong	3
,, 24	W. light	3
,, 25	N.W. light	3
,, 26	N.W. strong	3
,, 27	,, ,,	3
,, 28	,, ,,	5
,, 29	,, ,,	6
,, 30	,, ,,	6
May 1	N.W. moderate	6
,, 2	,, ,,	7
,, 3	S.W. strong	6
,, 4	N.W. moderate	6
,, 5	,, ,,	9
,, 6	N.W. strong	9
,, 7	,, ,,	8
,, 8	N.W. light	17
,, 9	,, ,,	20

(May 10–18, weather quiet, with light easterly winds. Female Willow-Wrens mostly arrived May 15–18.)

(The census of the wood was taken in the afternoons, as through-passage males were frequently present in the early hours of the day; almost invariably these had passed on by midday.)

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The facts of departure from nesting-haunts are always more difficult to grasp than those of arrival. It seems, however, that many of the adult Willow-Wrens leave their breeding-grounds in the end of July, and perhaps the only birds remaining are those with late broods. This departure, however, is largely concealed by the leisurely through-passage of the birds from further north. Young birds commence to wander as soon as they are independent of their parents, and by mid-July, in a normal season, many show themselves in gardens and other spots hitherto strange to the species. Through-passage of northern birds continues throughout August, but rapidly thins out in September, and usually all have passed on by the end of that month.

Distribution of Pairs and Nests.—In 1910 the wood, which, as already stated, is 25·999 acres in extent, held twenty-two pairs of Willow-Wrens, and, in addition, what appeared to be two unmated males. (The "song-centres" of these two birds are indicated in the map thus: XXIII, XXIV.)

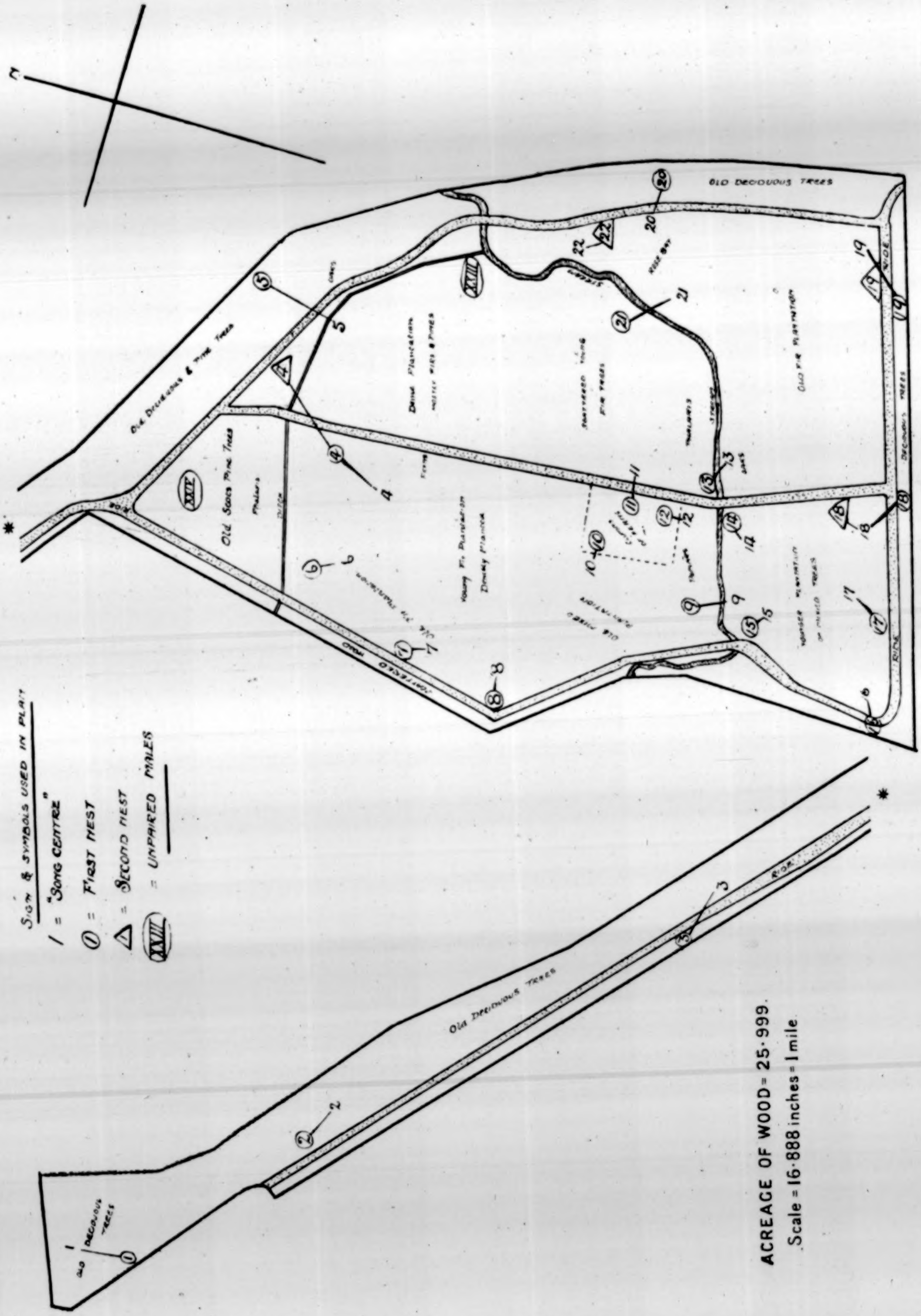
That mateless birds occur, even amongst our small Passerines, can scarcely be doubted. The fact, when it exists in such an abundant species as the Willow-Wren, is not very easy to appreciate, but in one or two other warblers, notably the Blackcap, I yearly meet with instances. In this county—unlike its relative the Garden-Warbler, which is generally, though sparingly, distributed—the Blackcap is local and somewhat irregular in appearance. The fact that males are more abundant than females has been repeatedly indicated by the arrival of scattered birds of the former sex in spring, which settle down in suitable haunts for some weeks, and, failing to procure mates, wander away into fresh ground in June or early July, whereas those few which are mated remain until August. The same phenomenon is to a lesser extent apparent in the Garden-Warbler. It is probably these wandering, unpaired birds which so frequently show themselves at curious times of the year in localities where none of the species breed. Thus, I have records of solitary male Blackcaps appearing in non-breeding spots in June 27th, July 2nd, July 3rd; Garden-Warblers on July 1st, July 7th; and Wood-Wrens on June 20th, June 22nd.

Another local instance, somewhat similar to those of Blackcap and Garden-Warbler, is the Sedge-Warbler. In 1908, owing to disaster during migration or other cause, there was a great shortage in the number of Sedge-Warblers, and several nesting areas, including the wood with which this article is specially concerned, were entirely deserted by the species. No recovery in numbers was apparent in 1909, but in the following spring some of the former haunts began to fill up, and three males settled in the wood. But only one of these obtained a mate and nested, the other two remaining solitary throughout May and into June, disappearing altogether in the latter month.

These three cases of Blackcap, Garden-Warbler, and Sedge-Warbler seem to afford some evidence that the males are the pioneers in the settling of new breeding areas. The fact that the females follow them in smaller numbers is at least suggestive of numerical inferiority in that sex.

Returning to the Willow-Wren. The accompanying map, for the preparation of which I am indebted to my friend Mr. R. M. Adam, shows the position of twenty-five nests, twenty-one of which are first broods. It will be noticed that these nests are somewhat irregularly distributed throughout the wood, more so than the singing-posts of the males. This is to be partly explained by the fact that, while the males show little preference in the choice of their singing-posts, the females dislike dense cover for their nests, and the latter are consequently placed in whatever open spaces are readily accessible.

It is necessary here to say a few words on these singing-posts and their relation to the nests. On reaching their breeding-haunts the males soon settle down into regular beats, confining their feeding-excursions within certain more or less definite limits. The areas comprised within these limits have been designated the "territories" of the birds, and the term is a convenient one, since such restricted areas do undoubtedly exist amongst many of our summer birds. At the same time my experience leads me to doubt whether too much stress has not been laid on the precise and sharp demarcation of these territories. Speaking here solely of the Willow-Wren, it seems that the facts are roughly as follows: In each territory there exists a tree or group of trees chosen by the male as his headquarters, and here a large proportion of his time is spent prior to the



ACREAGE OF WOOD = 25·999.

Scale = 16·888 inches = 1 mile.

arrival of the female; less during pairing-time; again more during incubation; and less during the rearing of the brood. While these singing-posts—or "song-centres," as they may be called—are only exceptionally intruded upon by neighbouring males, adjacent territories may overlap—that is to say, their outlying parts may be common to two or even more males. This mutual encroachment of different birds is most pronounced, naturally, in woods thickly populated by the species. Further, on the arrival of the females, the males extend their rounds temporarily, visiting spots hitherto ignored, and, as will be repeated presently, nests may be built in such places. In short, it would be quite impossible, without drawing too largely on the imagination, to mark off in the map of this wood definite boundaries dividing the individual territories from one another.

From the nebulosity of the dividing lines it follows that neighbouring birds frequently meet. When this happens, conflicts may take place, but quite as frequently the birds ignore each other. Males are the more jealous, but on occasion I have known the females attack and drive away others of their sex.

The choice of the nesting-site appears to lie with the female, and it may be pointed out that, of the twenty-one first broods in the wood, in no instance was the nest situated immediately beneath or beside the male's song-centre; usually it was at some considerable distance, and in a number of cases in ground not previously included in the male's beat. This latter fact, perhaps, need not surprise one. There is nothing to show that the female has any cognizance of what constitutes the limits of her mate's territory. Certain it is, at any rate, that she repeatedly passes beyond these limits, and in some cases nests outside them. An interesting illustration of the latter case is furnished by the three nests, Nos. 10, 11, 12. Here an open fern-grown piece of ground, nearly clear of trees, and surrounded on all sides by thick growth, has been selected by three different females for nesting-quarters, although none of the males included this part within their territories. Two of the nests were situated only thirteen yards apart. At the same time it seems that in woods of thin growth the nests tend to be on the average nearer the song-centres. No doubt in this respect, as in others, environment is not without effect on the habits of the birds.

It may, perhaps, be not altogether superfluous to give from my notes one or two short extracts, selected as illustrating different points in the relationship of neighbouring pairs of birds :—

"May 20th, 11 a.m.: Watched Willow-Wren building. The situation chosen for the nest is apparently outside the male's territory, since on all previous visits he was never observed to approach nearer than a point some fifteen yards distant. To-day, however, he was notably much more restless than usual, being incessantly on the move, and frequently visiting spots previously unknown to him. . . . A third bird (female ?), during the half-hour I remained, was frequently feeding quietly within a few yards of the nest. Though it could not but be visible to the other birds, no attention was paid to it.

"May 21st, 3.30 p.m.: . . One bird, whose usual singing-post is in a wild cherry-tree, was observed to fly straight into the fir-clump, fifty yards away, which is the central point in the neighbouring bird's territory. Here it remained for some minutes, singing quietly, and then returned without molestation.

"May 20th, 3.50 a.m.: . . . Once the male from the next territory had penetrated almost to the quarry (the song-centre of male No. I.). Male No. I. soon noticed him, and pursued him instantly, chasing him for a long distance beyond his own territory.

"May 24th, 3 p.m.: Two pairs of birds watched. The males were frequently in close proximity to each other. On one occasion they were singing in two neighbouring trees whose branches interlaced. No jealousy shown. The female of pair No. I. several times wandered into the territory of the other pair, and once passed right through it to some unoccupied ground on the other side. This bird was watched building her nest—which is still unlined—in the top of a high bank within a few yards of the favourite tree of male No. II. Male No. I. kept in fairly close attendance on her, occasionally uttering the buzzing note, and passing from tree to tree in sluggish flight."

TABLE OF NESTS.

No. of Nest.	Site.	Direction of Opening.	Approximate Distance from "Song-centre."	Distance from nearest Nest.	Date of Laying.	Date of Fledging.	Clutch.
1	Side of grassy bank	west	15 yards	115 yards	(May 30)	June 30	6
2	Amongst dead grass-grown branches	south-east	12 ,,	115 ,,	(May 27)	June 27	6
3	In long rough grass, 1 ft. above ground	south	25 ,,	197 ,,	June 17	(nest deserted)	(incomplete)
4	Side of grassy bank	west	16 ,,	45 ,,	(May 23)	June 22	5
5	Base of fern-clump	east	40 ,,	45 ,,	June 2	July 2	6
6	,, ,,	south	20 ,,	42 ,,	May 25	June 26	6
7	Amongst dead leaves	south	25 ,,	42 ,,	(May 21)	June 22	7
8	Amongst dead grass-grown branches	south-east	24 ,,	68 ,,	May 26	June 28	6
9	In *Phalaris* clump	south-west	20 ,,	30 ,,	May 27	June 28	7
10	Amongst long grass	north-west	15 ,,	18 ,,	(May 28)	June 27	5
11	Base of fern-clump	south-east	30 ,,	13 ,,	June 4	July 4	5
12	,, ,,	north-west	22 ,,	13 ,,	(May 23)	June 25	7
13	Amongst long grass	south-east	19 ,,	10 ,,	(May 30)	June 30	6
14	In *Epilobium* bed	west	14 ,,	10 ,,	May 27	June 26	6
15	In nettle-bed	east	18 ,,	30 ,,	May 24	(young destroyed)	8
16	Amongst dead branches	south	25 ,,	58 ,,	May 28	June 29	6
17	In *Epilobium* bed	east	15 ,,	58 ,,	May 27	June 25	6
18	In grassy ditch below bramble-bush	east	30 ,,	71 ,,	May 26	June 26	5
19	Amongst dead grass-grown branches	west	23 ,,	50 ,,	(May 25)	June 25	6
20	,, ,,	east	35 ,,	62 ,,	(June 17)	July 16	4
21	In *Phalaris* clump	north	30 ,,	41 ,,	May 24	June 26	7
22	(Not discovered)	?	?	?	?	?	?

(Laying-dates within brackets are approximate only, the nests not being discovered before commencement of incubation. These dates are somewhat later than usual, the season being a backward one. The usual laying-time in this district is about May 20th.)

The two late nests, Nos. 3 and 20, may possibly have been second attempts due to the first nests having been destroyed, but I believe the more probable explanation to be that the females in these cases were merely slower in attaining breeding condition than their neighbours.

Willow-Wrens are successful beyond many birds in their nesting. Of the twenty-one nests in a wood by no means innocent of Stoat and Weasel, probably the most dangerous enemies of ground-nesting birds, only two came to grief, one being robbed when the young were half-grown, and the other deserted.

Addled eggs are less frequent in this species than in many others. Only one egg out of one hundred and twenty failed to hatch, and this exception was a dwarf specimen, the first laid egg of nest No. 14. Compare with Hedge-Sparrow or Yellow Bunting. Whether there is any particular bias as to the direction the nest should face is doubtful. In the foregoing list there appears to be a tendency to avoidance of north, but in order to decide the question it would be necessary to collect statistics of a very much larger number of nests. Unfortunately this detail has been neglected in previous years' records.

After the fledging of the young the nests were taken to pieces and their composition fully noted. These have been omitted from the table to avoid a redundancy of details. Considerable variation occurred. The following case (nest No. 15) may be taken as representative, description commencing with exterior: Few dead leaves; little moss and dry fern-fronds; much dry grass, coarser at first, and of finer materials in inside cup, which is also much more closely interwoven; lining of a few horsehairs, rootlets, and one hundred and twenty feathers, mainly Pheasant's. Dead leaves, moss, and fern-fronds are not always used, and the lining of horsehair and rootlets may likewise be absent. The feather lining is not always quite distinct from the grass material, *i. e.* the bird, after having commenced the lining, may add further grasses amongst the feathers. The quantity of feathers used varied between fifty and two hundred and twenty in number. Eleven nests had a predominance of Pheasant's feathers; six showed preference for those of Ring-Doves; the remainder were more varied.

The commonest clutch is six. Thus there are: 1 four, 4 fives, 10 sixes, 4 sevens, 1 eight; while the clutches of the four second broods were 3, 3, 4, 4 respectively. The size of clutch in birds is sometimes a little loosely stated. Most authorities give the Willow-Wren's clutch as six to nine or five to eight. But four is not a rare clutch, and three is found now and then—even with first broods. There can be little doubt that in this matter as in many others there is considerable local difference, and detailed lists of clutches from each county in Britain—if we had them—could not fail to be of considerable interest from several aspects. To be of real service, however, such lists would require to include a large number of nests, and also to extend over a series of years, since it seems that—whether the cause be directly climatic, or through the food-supply*—there is variation in different seasons.

It seems probable that in the Willow-Wren, as in so many other birds, the same nesting-haunts are resorted to in successive seasons by the same individuals, and this no doubt applies to both sexes. Where different pairs breed in such close proximity, as in the present species, evidence is somewhat difficult to collect. The best instance in the wood is perhaps that of pair No. 19. In 1908 this pair nested in a small spruce-bush, about two feet from the ground. The following year (1909) the nest was built amongst some prostrate grass-grown dead branches, twenty yards away from that of the previous season. The 1910 site was within eight yards of the 1909 one, in a similar situation, and, most interesting of all, the second brood was reared in the 1908 nest in the little spruce-tree, which, owing to its sheltered position, had remained practically intact for two years. It was used by the bird without any repair beyond the addition of a few fresh feathers in the lining. This adaptation of an old nest in the Willow-Wren is unique in my experience. It is perhaps reasonable to assume that one female was responsible for all three nests. Although only eight first broods and five second broods were located in the wood in 1909, it may be worth while to state their relationship to 1910 nests. Excluding the instance just cited, the facts are:—

Of seven first nests in 1909, five were within fifty yards of 1910 sites (first nests): 5, 6, 40, 40, 48 yards respectively.

Of five second nests in 1909, four were within fifty yards of 1910 sites (first nests): same spot, 2, 30, 49 respectively.

The remaining two first nests and one second nest were at greater distances.

General Habits.—Broadly speaking, male Willow-Wrens may be said to pass through four stages after their arrival in their breeding-haunts, each stage being marked by characteristic behaviour. There is, first of all, the period previous to the arrival of the females; secondly, the period between the latter's arrival and the commencement of incubation; thirdly, the interval during incubation; and, lastly, the extent of time between the hatching of the young and their becoming independent of their parents.

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* Age is another probable factor, not necessarily constant in its application, since the proportion of young breeding birds may vary yearly.

During the first period—that previous to the arrival of the females, which may extend from a fortnight to nearly a month, as in 1910—the life of the males is a systematic and regular one. Commencing their song in the morning a little before sunrise (one of the last birds to do so, being frequently an hour later than such early birds as Sky-Lark or Song-Thrush), they sing most persistently and regularly for the first hour or two, feeding little, and spending the greater part of the time in the "song-centre." They are decidedly more sedentary than later in the day, frequently remaining motionless on a twig for several seconds together, only their heads moving restlessly. The songs are loud, and uttered with the utmost regularity, with pauses between of about ten seconds in duration. As the day advances they begin to feed with greater freedom, and extend their excursions, but still exhibit distinct preference for one particular part of their territory. Fights with neighbouring birds are frequent, though seldom very earnest, usually consisting merely of an aerial twirl or two, accompanied by a little menacing bill-snapping; during these encounters snatches of the song may be uttered in a low tone.

On the arrival of the females the commencement of the second stage in the male's year is evidenced by a marked change in behaviour. In place of the comparatively sedentary habit, and loud, regularly uttered song distinctive of the previous period in the early hours of the day, an extreme restlessness becomes apparent, and the song is now low in tone and very irregular in utterance, whole minutes together of silence sometimes elapsing. For the time being the song-centre is almost entirely deserted, and incessant wandering over a wide area becomes characteristic, this wandering frequently taking the male beyond what has hitherto been the confines of his beat. It is at this time, too, that a low "cheep, cheep" begins to be uttered between the songs, and this feature becomes more prominent as the days elapse. He follows the female at varying distances, his body and wings occasionally shivering with suppressed excitement, and now and then, on approaching her very closely, he utters a strange trilling or "buzzing" note—impossible of translation—waving his wings gently. At other times he will dart at her, and pursue her with lightning speed through the trees. Again, after remaining for a few seconds on an upper bough in a motionless and curiously constrained attitude, he will float downwards towards the female with slow-flapping wings—a dainty performance, which lives in the memory. The female is much less demonstrative, the only sign of emotion being an occasional shiver of the wings.

Although much more frequent and energetic during the first hours of daylight, these "courting" habits are commonly in evidence in modified form during the day. I have witnessed them as late as 5 p.m.

Coition, her readiness for which the female signifies by a gentle waving motion of the wings, takes place at various times of the day, most frequently, apparently, in early morning, but at times late in the afternoon. In two pairs of birds this year (1910) it was first noticed three and two days respectively before the laying of the first egg. Probably each egg requires separate fertilization, although it is a matter of very great difficulty to obtain complete evidence in wild birds. It is certain, at any rate, that more than one pairing may take place; I have noticed coition in species representative of such widely different families as Willow-Wren, Moorhen, and Long-eared Owl, after part of the clutch had been deposited.

Nest-building devolves entirely on the female. I have at least never yet seen the male take any share in the work. While it is in progress he pays only irregular attention to his mate, pursuing her playfully on occasion, but frequently wandering some distance away from her. Restlessness and excitability still mark him however. Materials are usually fetched from only a short distance, and the hen frequently gets into the habit of visiting certain spots in search of them, even giving herself unnecessary trouble to do so. The rate of construction appears to depend largely on the physical condition of the female, and in some cases is very rapid, building proceeding at intervals all day, and nests may contain the first egg within six days from the date of the commencement of building. Egg-laying seems to take place usually from 4 to 6 a.m., the birds leaving their nests again before 9 o'clock. There are exceptions, however. For instance, one bird (No. 18) did not lay her first egg until after 10 a.m.; the second was deposited before that hour on the succeeding day; and the third between 10 and 11 a.m. on the third day. One egg is laid each day. As the eggs increase in number the birds begin to sit for longer periods, and incubation may commence before the full clutch is deposited. In this respect there is great variation, some birds incubating from the fourth or fifth egg, others waiting until the clutch is complete, and, exceptionally, even a day longer. The hatching of the young, consequently, may extend over a day or two.

During the laying of the eggs, and before incubation has commenced, the male continues to pay considerable, though intermittent, attention to the female. His behaviour, however, undergoes some slight modification. His excitement decreases, he becomes more sedentary, and his song, although still low in tone, is uttered more frequently and is unusually prolonged, the "cheep" note being almost invariably interpolated. On the female going on to lay, he escorts her to the nest, and then, deprived of her stimulating presence, he shows a tendency to revert to his old habits of the period previous to her arrival. He returns to his old "song-centre" and resumes his customary mode of life; the song becomes louder and more normal, the "cheep" note being comparatively little uttered. This note, however, persists with some males throughout the summer; the mental attitude underlying it is difficult to appreciate.

With the commencement of incubation, the third stage in the male's year, already foreshadowed during laying-time, comes into being. The habits of this period are largely a repetition of those of the first. The "song-centre" regains its ascendency, and from that point of vantage the old excursions round the area recommence, varied by indeterminate tussles with other males. I have not observed them feed their mates during incubation; they may do so exceptionally, however, since I have seen them carry food to the female as she sat brooding newly hatched young. (It is in fact dangerous to generalize; no two birds behave exactly alike throughout the season.) They rarely go near the nests, only chasing the females playfully when the latter are on their short feeding-excursions.

The hens sit very constantly, only leaving their nests for a few minutes in search of food at various times of the day, but apparently chiefly in early morning and again about sunset. Incubation lasts twelve to thirteen days, the young spending thirteen to fourteen in the nest. These are average periods; here again there are differences, sometimes puzzling, between neighbouring nests—in one case, nearly fifteen days were required for incubation. The shortest time spent in the nest by broods is twelve days, but thirteen or fourteen is more common. If disturbed, they are able to flutter out when only nine or ten days old. When the young are still only a day or two old much time is spent brooding them, the female feeding them once or twice, and then covering them for a considerable interval before going off for a fresh supply of food. These intervals of brooding decrease in extent day by day, and cease finally when the young are about eight days old. At this stage, too, the female no longer broods them by night, and roosts elsewhere; but this may be merely a question of room—six or seven nearly fledged Willow-Wrens in a nest are a lesson in tight packing! With the hatching of the young the male normally enters on his fourth stage. He takes, as a rule, a fair share in the rearing of the family, and less time is consequently passed in the "song-centre." The song, however, continues practically unabated, being repeatedly uttered while the bird's bill is full of caterpillars. Some males commence to assist their mates as soon as the young are hatched; others ignore the latter for some days. In one case the male only tardily realized his duties when the young were nine days old. The following notes, referring to nest No. 8, when the young were three days old, may be taken as typical of that stage; here the male had not yet taken any notice of the young birds, though he did so a little later on:—

"June 16th, 11.50 to 12.50 p.m.:—11.50, female on nest; 11.55, female left nest; fed young 11.58, 12.0, 12.10, and then brooded until 12.20; fed young again 12.23, 12.26, 12.29, 12.32, 12.36, and then brooded until 12.45; had not returned by 12.50. Thus in the hour she fed the young eight times, and brooded them for intervals of ten and nine minutes."

Another record, referring to nest No. 16, when the young were a few days older (six days old):—

"June 21st, 10 to 11 a.m.:—10.1, male fed young; 10.2, female fed and then brooded; 10.5, male fed; 10.9, male fed; 10.10, female left nest; 10.11, female fed; 10.12, male fed; 10.17, female fed; 10.23, male fed; 10.24, female fed; 10.25, male fed; 10.27, male fed; 10.28, female fed and then brooded; 10.29, male fed; 10.30, female left nest; 10.30, male fed; 10.31, female fed and then brooded; 10.32, male fed; 10.37, male fed; 10.37, female left nest; 10.38, both fed; 10.39, female fed; 10.40, male fed; 10.42, female fed; 10.43, female fed; 10.45, female fed and then brooded; 10.47, male fed; 10.58, female left nest." Summarizing: the male fed the young fourteen times in the hour; the female fed them eleven times, and brooded for four intervals of eight, two, six, and thirteen minutes.

A very large proportion of the food brought to the young consists of insect-larvæ. The quantity destroyed must be enormous; a rough calculation showed that the young broods in this wood, when nearly fledged, must have consumed a minimum of something like 7500 larvæ per day! It is an interesting fact that after the young have left the nest, larvæ form a much smaller proportion of their food, the imagos of Diptera, and apparently certain Heteroptera (*Psallus*, *Phytocoris*, &c.), becoming the chief resource. The second broods are also fed principally on Diptera, both before and after leaving the nest. This change of food, however, may be merely a local phenomenon, due to increase or decrease in certain forms of food. The fledged young remain in charge of the female—the male takes less interest in them—for some ten days after quitting the nest. The first day or two of this period is spent in the vicinity of the deserted nursery, but as the young gather strength and confidence, they soon begin to wander into new ground, the female accompanying them. Soon they become quite capable of feeding themselves, picking insects off the leaves and springing after those on the wing with the skill of a Flycatcher. Towards the end of the ten days, the old bird ceases altogether to act as food-provider, and becomes merely the sentinel of the family, ever watchful for sign of danger. By the middle of July many of the young birds, recognizable by their yellow plumage and immature call-note, leave the place of their birth altogether, wandering leisurely southwards.

Judging from the systematic observation of the last two years in this wood, it would appear that the local proportion of Willow-Wrens having second broods is about fifteen to twenty per cent. In 1910 there were four second nests, from three of which broods were reared, one having the eggs destroyed. (These nests belonged to pairs Nos. 4, 18, 19, 22; they are indicated in the map thus △.) The intervals between the fledging of the first broods and the commencement of laying for the second clutch were, in three of the cases, approximately ten, fifteen, and eight days respectively; the sites being seventeen, twenty, and fifty-five yards distant from the first nests. As already stated, the food of the second broods, both while in the nest and after leaving it, consists chiefly of Diptera in the mature form—a decided contrast to that of the first broods. Another point of distinction is that the males frequently take no share whatever in the feeding of these late families. This was the case in all three second broods reared in 1910, although in each instance the males had taken their share with the earlier families. The explanation appeared to be that they had by that date (late July) already departed from the locality, leaving their more dutiful mates to their own resources. In the previous season, however, when the broods were a week earlier, the males in some cases assisted in their rearing, so that there is no invariable rule in the matter. The rate of feeding is decidedly more rapid with these second broods. Thus while first broods, when nearly fledged, are fed (by both parents) from fifteen to thirty times in the hour, second broods at the same stage of development—even when tended by the female alone—are fed at the rate of thirty-five to fifty times per hour. One bird was observed to feed her young seventy times in that period—an astonishing performance, the more so that it took place in an exposed locality during half a gale of wind. This increased activity is no doubt chiefly due to the greater abundance of food in late July, but the desire of the birds to set out on their southward journey is probably a contributory cause, making them restless and eager in their work.

The vocabulary of Willow-Wrens is an unusually limited one.

Apart from the song, the principal notes are: the "pooee" call and alarm-note (chiefly used as the latter); the buzzing-note of the male during pairing-time; the "cheep" note introduced on certain occasions between the songs. Other notes are uttered, but are less well-marked. Frequently a distinct difference between the call-notes of male and female in particular pairs can be detected, but I have been unable to satisfy myself whether this distinction is a sexual one, or merely individual. The note of the young on first leaving the nest is a very hoarse imitation of the "pooee" of their parents, and suffices to distinguish them for some time. The song usually wanes in July, and ceases between the middle of that month and early August. In some seasons, however, the break is hardly perceptible.* A few young males commence to sing in late July or early August, but the bulk of the autumn song, which extends into September, proceeds, I believe, from the old males, which after their moult are little less yellow than the young, and therefore not easily distinguished. I judge rather from the comparative excellence of the song. Once, and once only, I have heard a female try to sing. This was in May, during pairing-time, and appeared to be the outcome of sexual excitement; the song was very feeble, consisting merely of a few stammering notes, uttered very similarly to the very earliest efforts of the young males in autumn.

In August, among the roaming, playful, inquisitive bands of old and young, a recurrence of the buzzing-note of the courting season is repeatedly to be heard during early morning and forenoon. The birds uttering it appear to be mostly, if not entirely, old males. The accompanying song is low, but complete in utterance and prolonged; while the "cheep" note is also occasionally emitted. Indeed, except for the comparative absence of excitement, the bird's bearing is strongly reminiscent of that shown in May, about egg-laying time. This behaviour is interesting, showing apparent analogy to the autumn displays of such birds as Black Grouse.

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* The break is longest in dry and warm seasons; shortest in wet and cool ones.

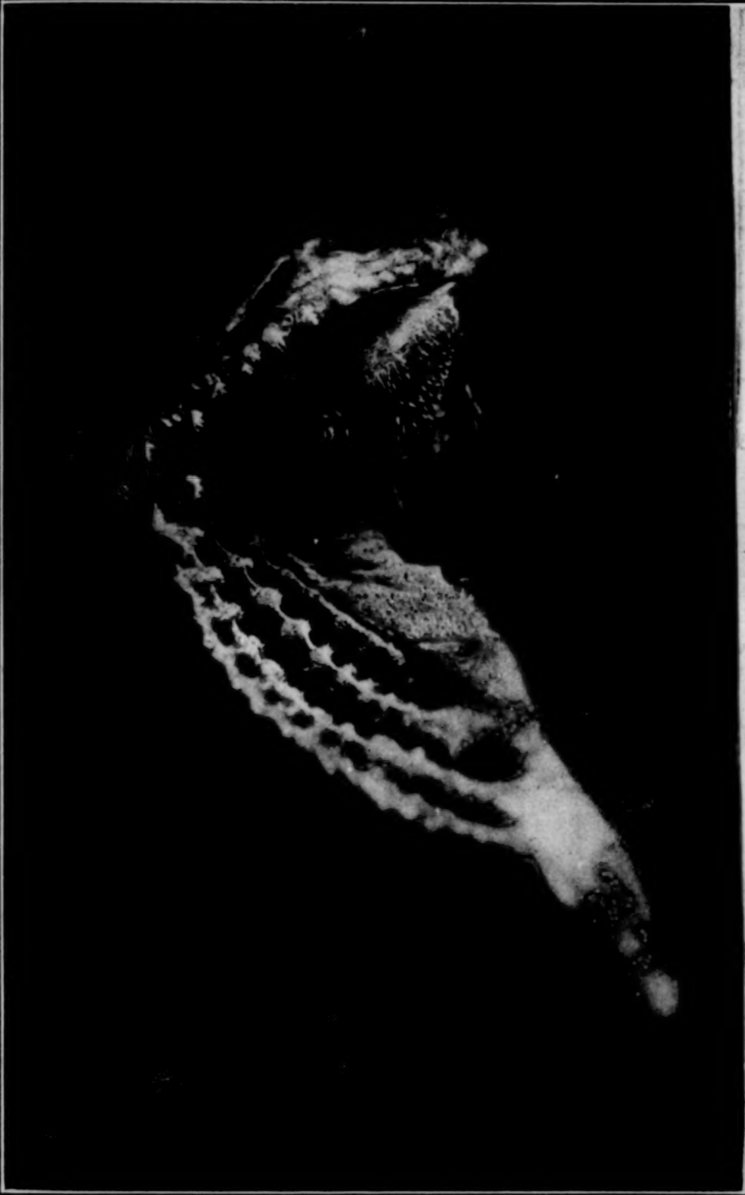
PHARYNGEAL TEETH OF FISHES.

By Colonel C. E. Shepherd (Indian Army).

(Plate II.)

The teeth of fishes, whether those visible on a cursory examination of the external characteristics of a fish, or those in the anterior part of the buccal cavity on the vomer, the palatine and pterygoid bones, and on the tongue, furnishing important data for the identification of a fish, have in all works on fishes received a good deal of notice, and are usually fully remarked on. But there is another set in the mouths of most Teleostean fishes that also deserves attention, but which, as a rule, has received very little notice. This is the set of the pharyngeal teeth, which, except in the case of the families comprising Wrasses and Carps, have received but scant and more often no attention. Anyone interested in this question can verify the importance of these teeth for himself by a short visit to the British Museum of Natural History at South Kensington. Here, by inspecting the show-case devoted to the anatomy of fishes in the small alcove off the Central Hall, the pharyngeal teeth of the Cod, Pike, *Amia calva*, Ballan Wrasse, and the formidable pharyngeal teeth of the Sunfish (*Orthagoriscus mola*) can be seen. In the large room set apart for fishes, by looking up into the mouths of the skeleton specimens of *Sciæna aquila*, *Bagarius yarrellii*, and *Lates niloticus* the pharyngeal teeth may be seen, and those of the Angler (*Lophius piscatorius*) can be studied. In a case, but separated from the skull, the very curious pharyngeal teeth of *Pseudoscarus muricatus* can be seen, and are well deserving of attention.

Pharyngeal teeth may be either villiform, which are very fine teeth, feeling almost like a smooth file to the finger; or cardiform, which are much stouter with a backward curve to them—this kind of tooth runs up to a comparatively large size,



1. Right half of SERRANUS GIGAS.
2. SERRANUS SCRIBA.
3. APOGON REX MULLORUM.
4. CENTROPRISTES HEPATUS.

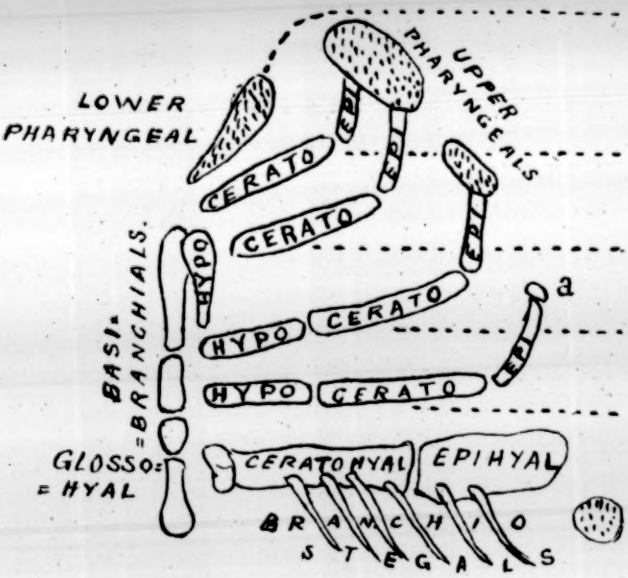
as in the Sunfish. Or the pharyngeal teeth may be crushing teeth of a granular form, as in the Wrasses (*Labridæ*); or molariform, set on stalks, and biting against a horny pad, as in the Carp family (*Cyprinidæ*); or of a pavement-like structure, as in the *Pseudoscarus muricatus*; or setiform, like bristles, as in the Black Pomfret (*Stromateus niger*).

The external teeth and those in the anterior part of the mouth are adapted for seizing the fishes' prey. The pharyngeal teeth are, probably, the principal masticatory organs; in the Carp family (*Cyprinidæ*) they undoubtedly are. Some Teleostean fishes, *e.g.* the Twait Shad (*Clupea finta*), are devoid of any pharyngeal teeth. Fish that prey on other fishes and that swallow them whole would have the action of their gastric juices much facilitated for the process of digestion, if the scales of the swallowed fish were scarified and torn by the pharyngeal teeth, as they must be in the process of swallowing, rather than if the fish arrived in the stomach with its scaly covering intact; while fish that live wholly or partially on crustaceans, which may be called "the staff of life" for fishes, can give them a scrunch in passing through their pharynx that must loosen the shell of the crustacean and facilitate digestion. The Wrasses (*Labridæ*) that feed on shell-fish have their granular teeth in the upper and lower pharyngeals adapted to crush the shell, they not being provided with teeth in the front part of the mouth for this work, as is the case in the Sea Bream family (*Sparidæ*). The Carp (*Cyprinus carpio*), a vegetarian, finds its molariform teeth most useful for the masticating of its food, as do no doubt the rest of this family. The pharyngeal teeth also help largely in working the food down into the œsophagus, especially in those fish that have strongly cardiform teeth; and as the pharyngeal teeth are surrounded and embedded in mucous membrane, they probably, by their lacerating the skin of the prey, enable a fish to get a taste of what he is eating, a pleasure that fishes are not generally credited with enjoying.

To form a correct notion of the pharyngeal teeth and their place in the mouth, it would be well to get a general idea of the anatomy of this part. The accompanying diagram may help to impress on the mind the names and general situation of the bones. It is typical of the left half of a fish's gullet.

There are four gill or branchial arches that bear gills; the fifth branchial arch is stunted, bears no gills, but is furnished with teeth. The first three branchial arches, counting from the outside, are each composed of three bones—the hypo-, the cerato-, and the epibranchials. In the fourth arch the hypobranchial is absent. The first branchial arch terminates in a small bone that helps in the attachment to the base of the skull, it is called the *upper epibranchial of the first branchial arch*. The second, third, and fourth arches terminate in the *epipharyngeal* bones, which carry teeth. The outermost arch is the longest, and they decrease in size inwardly; the *hypobranchials* are connected with the *basibranchials*—they and the *ceratobranchials* form, as it were, the floor of the gullet; the *epibranchials* curve upwards and meet together at the base of the skull, forming, with the *epipharyngeal* bones, the upper part and back of the gullet, the epipharyngeal bones being one above the other, with that on the fourth branchial arch as the lowest. The fifth arch, the *lower pharyngeal bones*, with its teeth, is on the lower part of the floor of the gullet, and in advance of the œsophagus. The above is approximately a description of the

Diagram showing Left Branchial Arches and Bones connected therewith.



5th branchial arch, which bears no gills, is dwarfed, and called the lower pharyngeal bone.

4th branchial arch; the hypobranchial is absent.

3rd branchial arch.

2nd branchial arch.

1st branchial arch with a small bone at the top "a" called the upper epibranchial of the first branchial arch.

.. Bones bearing pharyngeal teeth.

The 1st, 2nd, 3rd, and 4th branchial arches all bear gills.

general scheme in the anatomy of a fish's gullet. It is subject to modifications in different cases, which will be noticed, if important, when treating of different fishes where such occur.

The branchial arches on their concave surface carry the *gill-rakers*, horny protuberances, often like the teeth of a rake, but in some forms they may be teeth-bearing tubercles more or less prominent, or the tubercles may simply be rough. These gill-rakers are provided to prevent solid particles that might injure the gills being carried into them; in some cases they form a perfect sieve, in others but a very inefficient one. The horny rake-like teeth, which are often denticulated, are generally on the outer side of the first branchial arch, and the tubercle forms on the inside of this and on the inside and outside of the second and third branchial arches, and the outside of the fourth. In some fishes the rake-like gill-rakers are on all the branchial arches. No account of the teeth in the pharynx of a fish would be complete without noting the teeth that in many cases bristle on the tubercles, or that line the inner side of the rake-like protuberances. In the following descriptions, therefore, the gill-rakers and the teeth on them will be noted, as well as those on the pharyngeal bones themselves, and also the teeth that are found along the surface of the epibranchials, yet distinct from those on the epipharyngeal bones.

SERRANUS GIGAS. Dusky Perch (Couch). Plate II., fig. 1.

This fish is occasionally caught in British waters. The detailed description of pharyngeal teeth may well begin with this fish, for it possesses a perfect armoury of sharp teeth in the posterior part of its mouth, as can be seen in the illustration. On the first branchial arch the gill-rakers are short and stout; there are sixteen of them from the angle of the cerato- and epibranchial towards the end of the hypobranchial, and nine along the epibranchial on the outer face of this arch. They all bear teeth on the inner side. The one at the angle is the longest, and has twenty sharp cardiform teeth on it; its length is contained about seven times in the length of the cerato- and hypo-branchial of this arch. There are teeth bearing tubercles on the inner face of this arch, which along the cerato- and hypo-branchial correspond with the position of the outer gill-rakers. There are tubercles also along the epibranchial portion of this arch. The second and third arches have, on each side, tubercles bearing teeth; the fourth has them on the outer side. All these teeth are cardiform. The upper surface of the lower pharyngeal bones have a long, roughly diamond-shaped patch of villiform teeth, with a double row of strong conical-shaped, pointed teeth along the edge nearest the swallow. The lower pharyngeal teeth are seen near the centre of the illustration. The upper pharyngeal teeth consist of a long narrow patch at the top of the second epibranchial, two patches on the third epibranchial, and two patches on the fourth epibranchial. These latter four patches look like two on a cursory examination; it is only by working the bones that the division in them is realized. All are studded with strong cardiform teeth. By counting the teeth on some of the gill-rakers and on the tubercles, and taking an average of the teeth and the number of tubercles, and counting the upper and lower pharyngeal teeth as carefully as possible, a very moderate estimate would give the number of teeth in the inner mouth of this fish as three thousand two hundred. There are probably more.

SERRANUS SCRIBA. Plate II., fig. 2.

The gullet of this fish is a small-size replica of that of the preceding fish; the gill-rakers are modelled in the same way. On the outer side the first branchial arch has fourteen gill-rakers from the angle of the cerato- and epi-branchial to the end of its hypobranchial, and six along the epibranchial. The one at the angle is the longest, and about the same length as the gill just under it; the gill-rakers diminish in length in both directions as they get away from the longest one, till the further ones become flat tubercles. They all bear minute cardiform teeth on the inner face. There are tubercles on the inside of the first arch which bear teeth. The second and third arches inside and outside and the fourth arch on its outside aspect are studded with tubercles bearing small teeth. The upper pharyngeal bones bear villiform teeth, interspersed with some cardiform teeth. The lower pharyngeals carry villiform teeth, with a V-shaped row of conical upright teeth along the inside edge of the teeth-bearing plate, the apex of the V being towards the tongue. This illustration shows the curious case of a fish, not one of the *Pleuronectidæ*, with a crooked mouth. It will be noticed that the left side of the fish is not symmetrical with the right, the branchial arches are stouter, and the teeth-bearing plate of the fourth arch, the lowest of the upper pharyngeal teeth showing on the left side, is malformed and out of shape. This is due to a natural deformity.

APOGON REX MULLORUM. Plate II., fig. 3.

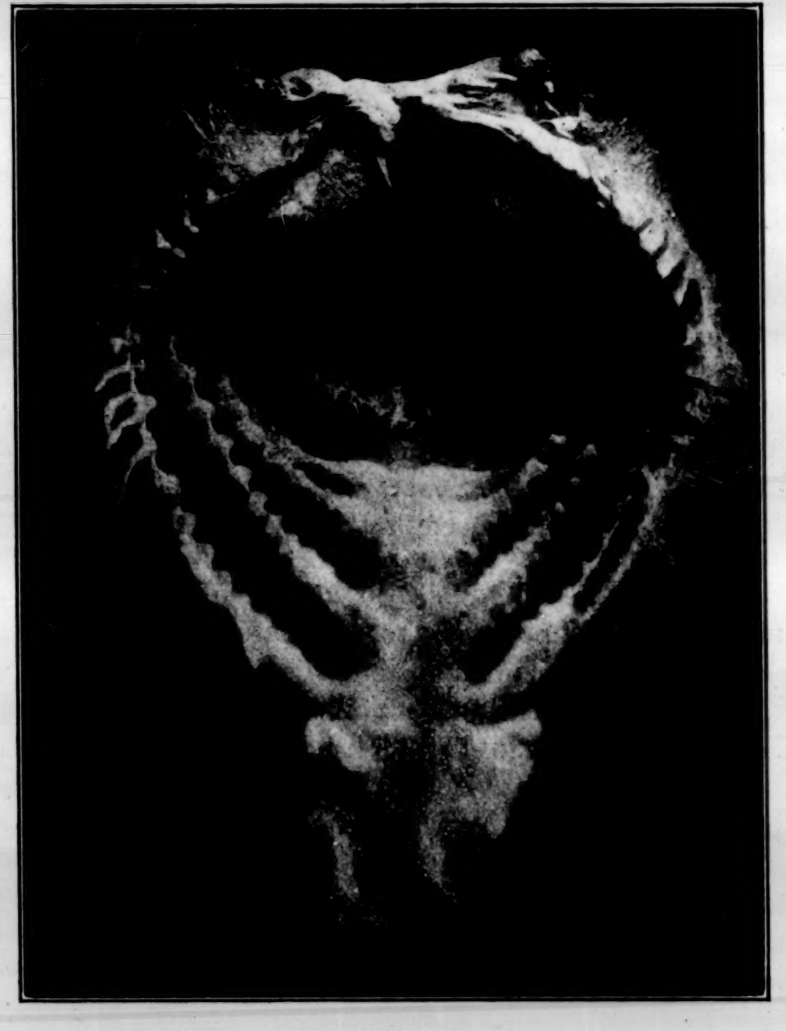
A small-sized representative of the *Serraninæ*, has on the first branchial arch twelve gill-rakers from the angle towards the tongue, and four up the epibranchial. These bear minute teeth on their inner faces, and diminish in size as they get away from the angle of the branchial arch. There are tubercles on the inner side of this arch. The second and third arches have tubercles on each side, the fourth has them only on the outer side. These tubercles bear minute teeth. The upper pharyngeals have villiform teeth, with some cardiform ones along the upper part, the disc bearing them attached to the third branchial arch being larger than the other two. The lower pharyngeals bear villiform teeth in two patches of a triangular shape.

CENTROPRISTES HEPATUS. Plate II., fig. 4.

Another small representative of the *Serraninæ*. The first branchial arch has twelve gill-rakers from the angle forward, and five along the epibranchial along the outer side. These carry teeth. The inside of the first arch has tubercles. The second and third arches carry tubercles on the inner and outer sides, and the fourth on its outer side. The upper and lower pharyngeal bones carry villiform teeth. The teeth on the lower pharyngeals seem to join each side in the middle; there is not that distinct middle separation line that is noticeable in the *Apogon rex mullorum* at this part.

MORONE LABRAX.

This fish frequents the coast of England in the summer, and is known to fishermen as the "Bass." The first branchial arch of the specimen illustrated has thirteen gill-rakers on the left side, whilst the right side has fourteen, in the length from the angle to the end of the hypobranchial. There are ten on the outside of the epibranchial. There are long horny gill-rakers in the middle portion of the branchial arch, the length of the longest being about one-fourth of the length of the cerato- and hypo-branchial combined. The gill-rakers dwindle in length from the angle each way, the last ones being short, but they do not become tubercles. All these gill-rakers carry fine villiform teeth on their inner side. On the inner side of the first arch there are distinct tubercles covered with fine villiform teeth. The second and third arches on each side of them, and the



MORONE LABRAX.

fourth on its outer aspect, carry distinct tubercles with similar teeth. On the inner side of the fourth arch there are very small tubercles. The lower pharyngeals carry two leaf-shaped patches of villiform teeth, with a row of cardiform ones along the edge at the back and in the middle, and a few others close to the back edge. Where the second arch hypobranchials join the basibranchials there is a patch of villiform teeth on each side, showing very faintly in the illustration. Between the junction of the second and third hypobranchials with the basibranchials on each side, but in the centre of the mouth, there is a patch of villiform teeth, roughly circular in shape, but divided down the centre. The upper pharyngeal teeth are strong villiform teeth, arranged in five patches—two elongated ones along the epibranchials of the second arch, a roughly four-sided patch on the pharyngeal bone at the end of the third epibranchial, with a smaller patch on the outer side along the arch-bone, and a roughly circular patch on the pharyngeal bone at the end of the fourth epibranchial. The "Bass," according to Couch, feeds on smaller fish, crustaceans, and seaweeds.

THE VOCAL AND INSTRUMENTAL MUSIC OF INSECTS.

By A. H. Swinton.

(Continued from p. 306.)

I remember, when in the Island of Mauritius, being presented with a live stick-insect, which, much to my astonishment, suddenly expanded its fan-folded wings with a silken rustle and seemed to leap out of the window. Mr. Wood-Mason asserted that one—a *Pterinoxylus*—made a sound by rubbing a rasp on the costal vein of its wings across their diminutive covers, which was augmented by a talc spot. Entombed in the coal-fields, the stick-insects, grasshoppers, and cockroaches seem to blend with the dragon-flies and stone-flies. Nowadays *Corydalis cornuta* looks like the ghost of a bygone insect with jaws, and the ant-lions only retain them in their youth. A bit of wing belonging to the *Corydalis brogniarti* of Audouin, that dwelt among the gigantic horsetails of Colebrookdale, I once suggested to Dr. Henry Woodward had traces of a circular musical comb, but later on a scientist pronounced this to be the mark of the fracture in the claystone nodule that enclosed it; while, from the nature of their inhabitants, it remains more than probable that these early swamps resounded with the savage shrill of insect instrumentation.

The caddis-flies, again, blend with the scaly china-marks, bagworms, and clothes-moths, the *Acentropus niveus* found in some English ponds being a connecting-link. Among the moths that spin cocoons a few have bladders under their wings that resemble the drums of the Cicadas, and it is said they elicit sounds from these by rubbing them with their hind legs, but they have not any very conspicuous ear-cavities. They are possessed by the males of two rosy-flushed tiger-moths of the Mediterranean seaboard (*Cymbalophora pudica* and *C. œrtzeni*). De Villiers compared the sound made by the former, when flying in the evening twilight, to the "tic-tac" of the needles of the housewife engaged in knitting stockings, and whenever I rub a hind leg of a desiccated specimen of the latter from a Jerusalem garden over the striations at the front edge of the bladder where the femur is wont to rest, I hear a noise like that made by the old black indiarubber when wetted; so, after being affrighted by the clatter of the Pheasant on the wing in a country lane, I can quite believe the assertion of De Villiers; both moth and bird seem sonorous. It is said the large "yellow tiger" (*Pericallia matronula*), rarely met with in the woods of Europe, possesses these balloons; they are just visible in the "Jersey tiger" and the "scarlet tiger" of our fenlands, but the common tiger moth that has caused an uproar which has been evident through a closed door is without them; it has good claws, and I have heard it scratch. They seem, indeed, to indicate a bygone relationship of the *Chelonidæ*, whose caterpillars feed on low plants, to the lichen-bred *Lithosidæ*, for the pretty flesh-coloured *Miltochrista miniata* that frequents the forest ferns has them faintly developed, and so has *Gnophria rubricollis* that flutters among the foliage. Those of the orange black-speckled *Setina*, met with in woods of Europe and Northern Asia, are far more conspicuous, and shine like spectacle-glasses; when Guenée held *Setina aurita* in his fingers, he declares that he heard it make a ticking like a watch, and a beating like a "death-watch" beetle. They may be found in the woods above Montreux, where they do not appear to be very common.

Mr. Henry Edwards, who passed his youth on the London stage, and later in life sat down to write a book on North American butterflies, has recorded his experience of the sounds made by Lepidoptera in the second volume of 'Insect Life.' Among other recollections, he tells us, when resting one day during the heat of the noonday sun under the shade of an acacia in the Plenty Ranges, some twenty miles remote from the bustle of the opulent town of Melbourne, how he was suddenly aroused from his reveries by the "whiz-whiz!" of two or three *Hecatesia fenestrata*, lovely orange-and-black moths, which were going in the fashion of the Swifts on the sidelong fling adown a woodland vista. On his return to America he heard the identical sound arise from a swarm of the *Alypia* *octomaculata*, members of an allied tribe, whose caterpillars destroy the grape-vines, and he felt confident that on both occasions he detected the clubbed antennæ playing the tattoo on the wings like drum-sticks. An idea here arises whether the talc spots on the wings of certain large falcate winged moths are not adapted to produce a social buzz; a schoolboy once told me he had made his kite buzz, but then he had cut a hole in it. Many stout-bodied moths whose caterpillars are cocoon-spinners, when they desire a partner, commence a vigorous wing-beating; the same rattle is heard when they are pumping in air to inflate their bodies for flight.

The "green silver lines" must be of lineage old, for their caterpillars construct the boat-shaped cocoons of the species of *Nola*, by some placed in the *Lithosiidæ*, as do those of some green moths which resemble the *Tortricina* in appearance. Forms that link the *Tortricina*, *Pyralidina*, and *Bombycina* are naturally ancestral; in one of the table-cases of the Marseilles Museum a tertiary moth with banded wings was to be seen. The fore wings of *Hylophila prasinana* have a sonorous pucker and a flap with a callosity that catches on the side-piece of the abdomen with a click, but as the moth executes its "scritch-scritch!" when flying, it would seem as if the callosity caught at the root of the veins of the hind wing. Mr. Kirby says this inhabitant of the oak-wood is common in Europe and Siberia. A specimen possessed by the British Museum used to be labelled "Australia." Some years the beating-stick brings it down plentifully in the New Forest, but as far as I know its twitter or squeak has only been heard in the north of our island. The Rev. Mr. Morris saw a large shoal of these moths flying and squeaking above the top of an old-fashioned hedge in a grassy lane at Stoke Court, and those seen by Mr. Headworth on June 4th in a wood at Gateshead, in Durham, were whirling frantically around one another in a waltz with a reiterated bird-like twitter, and a male that was captured squeaked on in delight until it was boxed. Dr. Buchanan White, on May 28th, heard a solitary male disconsolately squeaking as it gyrated around a small oak in Perthshire, and another later the same evening doing likewise, which looks as if there were a newly emerged female embowered in the silence. Those I saw come fluttering down in the thicket of sapling oaks on the banks of Loch Fyne after dusk were toying in the fashion of the Swallows on the china plate, and one, or both, was clicking its make-believe kisses. We could imagine these moths are not deaf; they possess ventral cavities at the junction of the abdomen and thorax that may be adapted for audition. By nature indolent, somnolent, and apathetic, it is surprising they have so much life in them. If the birds learnt to sing beside the pebbly brook, they are surely trying to imitate the chirpings of the verdant, vernal groves, which poets assure us "are ever full of song and full of love."

Many of the males of the lichen-dappled, mouse-coloured *Noctuina*, branded with their family heraldry of lines, kidney, orb, and dart, are consummate dandies, with an extensible fan on a fleshy arm at the base of the hind body, which, when it expands, scatters on the dusky air a fragrance of turpentine or the vinaigrette. From the information afforded by Mr. F. N. Pierce, in his laborious work on the genitalia of the *Noctuidæ*, added to my own very partial investigations, I conclude these hair-pencils are possessed by the male of the quadrifid *Mania maura*, sometimes called the "old lady," that flies, dismal and black, into the apartment that overlooks the willows; by that of the "angle shades" (*Phlogophora meticulosa*), whose green caterpillar eats the garden fennel, and by those of the "sharks" (*Cucullia verbasci* and *umbratica*), that hide in the herbage. They are possessed by the males of the "wainscots," veiny, straw-coloured, or purplish, that, when the twilight darkens, are all on a flutter over the flowering grasses of the marshland; those of *Leucania conigera, lithargyria, littoralis, vitellina, pallens, albipuncta, l-album, straminea, extranea, obsoleta*, and *congrua* are all provided with them, as are those of their near of kin, *Nonagria dissoluta, Caradrina brevilinea*, and others. One of this group, *Leucania loreyi*, is widely distributed; they rarely have the *Noctuina* pattern distinct. Scent-fans at the base of the abdomen are possessed by the males of certain moths, sometimes a canary-colour, that fly to lights in shady avenues; those of *Orthosia aurago* and *flavago, ypsilon, lota, macilenta*, and *pistacina*; and the males of *Caradriua subtusa* and *Conistra erythrocephala* thus secure a partner. So, too, do the males of a group coloured like the bark of the tree-trunks on which they slumber in our parks during the day; they are possessed by the males of the "grey daggers," *Acronycta tridens* and *psi*, and by those of the brown *Hadena rurea*, *basilinea*, *polyodon*, *satura*, *ophiogramma*, *hepatica*, *unanimis* and *scolopacina*, *Melanchra brassicæ* and *persicariæ*; by those of *Aporophyla nigra*, *Dipterygia pinastri*, and *Aplecta nebulosa*. Mr. Pierce finds that the male of the minute *Miana furuncula*, whose caterpillar feeds in the stems of the *Festuca arundinacea*, has these scent-fans, which suggests their use, was discovered in the fens, where the *Nonagria*, ancestral forms of the straw-coloured group, as would appear, in like manner emerge from the stems of reeds and bulrushes. The plumes of *Lamphygma exigua*, as portrayed by Mr. Pierce, are found at the extremity of the hind body unusually developed; they are inconspicuous or absent, according to the same authority, from the flat-bodied *Noctuidæ*, the "darts" and "yellow underwings" that fly out of hayricks; and I have not noticed that the night moths with lichen-mottled wings possess them; if the sweetly pretty "peach blossom" has also scented puffs, they may extend to the *Notodontidæ*. "Swifts" and a large number of the Geometers, the world over, carry their fans on their hind legs, and the "coloured underwings," placed among the night-fliers, have them on the second pair. I conclude it is from its habit of thrusting these forward when at rest on the elms and willows that *Catocala concumbens*, whose dainty pink renders it conspicuous among the North American "red underwings," has been said to have them on its front ones. Ought not its name to be pronounced "*concubens*"? I have recently found that *Melipolis sinualis*, a North American moth, has scent-fans continued in pockets on its second pair of legs. Other *Noctuina*, especially those of the genus *Plusia*, are adorned with a metallic glitter of spangles, but as all the moths have a more or less visible ear-cavity, with cells, drums, and attached ganglia on either side at the base of the abdomen, it would not be surprising to hear that they held sweet converse. An American entomologist says of *Catocala parta*, one of the "red underwings" frequenting the willows of Iowa at the close of the summer, "that it is the wariest of the genus, resting usually head up, hearing well, and taking flight at the snapping of leaves under foot." I quote from the 'Entomological News' of Philadephia for January, 1909; and I might mention that Mr. J. J. Fountain lately observed, in the 'Countryside,' that, when crossing at nightfall a meadow near Birmingham, he was surprised by a clicking sound, and suddenly found himself surrounded by the mustachioed males of *Heliophobus popularis*, that flew low over the grass where a newly emerged "feathered gothic" was holding its wings over its back and sounding the timbrel for a gathering. On examination I can only imagine the sound might have been made by the pucker at the base of the fore wing, but that *Orthosia flavago* makes a similar clicking, as stated, is astonishing. It was believed that Indian ants, provoked with a straw, began to hiss, until a question arose whether the sound was not made by their feet, as the boots of soldiers resound when a sudden halt is shouted.

The music of many insects is simply the din of a file with a chitinous resonance, recalling the rasping of a blacksmith's forge. I have never heard a spider emit any sound, but Mr. Wood-Mason has told the Entomological Society how *Mygale stridulans*, dislodged from a bamboo clump in Assam, on being attacked by his cat, elevated its head and threw its cheliceræ into rapid motion, when certain chitinous, club-shaped rods, arranged comb-like on the inner surface of the basal joints of the palpi, grating on the outer surface of their penultimate joint, made an alarming whistle, recalling the muttering of an old man who has lost his teeth. Mr. Wood-Mason mentioned at the time that he had also a musical scorpion preserved in a bottle of spirit. The mouse-like squeak of the "death's-head moth" is somewhat similar in causation. Along the south-eastern coast of England, as on the lands of Brittany, *Acherontia atropos*, some seasons, is not uncommon, and its large green caterpillar is then commonly found when the potato plots are dug up. In 1865, 1868, 1878, and 1885, according to Mr. Richard South, it was unusually plentiful in the British Islands; 1867, 1878, and 1883 were corresponding years of most and fewest sun-spots, when the atmosphere was perturbed. According to my father's pocket-books, 1867 was fine, but the autumn was stormy in Hampshire; 1878 was a succession of thunderstorms—I do not remember such a summer except the one of 1883. The summer of 1865 was also sultry but changeable. During 1885, as the year previous, the cholera was prevalent in India and the South of Europe. May was again cold, and the warm and humid summer in Surrey was productive of roses. Strange to say, this clumsy creature is sometimes seen flying out in the Channel. At the commencement of May, 1878 and 1882, individuals that had probably hybernated were taken on the coasts of Devon and Antrim. It is conjectured the "boanerge" squeaks in order to terrify the bees when it enters their hives to steal the honey, itself being deaf or dull of hearing, and inasmuch as the piping of the queen is understood to be a signal to swarm, and it is the custom to din on pots and pans when her colonists cluster around her on the horse-chestnut flowers, it is to be supposed that the bees who must hear, and who might perceive no evil omen in a skull and cross-bones, would quake with terror; invariably when it is disturbed it squeaks, but this would not hoax an Owl that feeds on mice. Still, this is not the only objection, for when the male moth squeaks it inflates its abdomen, and expands two yellow fans on either side into a star, which, like a composite flower, shed around their musky fragrance of jasmine or tuberose, comparable to that emitted by the feather tufts of the *Catopsilia* butterflies. At such times the "death's-head" has a remote resemblance to a large puff-ball. The alarming sound, according to Dr. Landois, is produced by the short tongue that it rubs along a striation in a groove that will be found at the base of the palpi, much as a scythe is whetted on the stone, for he discovered, when the palpi were removed, the moth could squeak no longer; and Mr. Joseph Anderson says, in the 'Entomologist,' that he is certain it is by the tongue that the squeaking is produced, for when he pressed it the noise ceased.

(To be continued.)

NOTES AND QUERIES.

MAMMALIA.

A Sheep-killing Horse.—One of the cart-horses on a farm here has lately developed an intense dislike to sheep, and savagely attacks these animals when he can get at them. On two occasions he has succeeded in killing his victim, and would in all probability have destroyed a third, had he not been driven off by the shepherd. He goes at them with extreme fury, striking with his fore legs, biting, kicking, and kneeling upon them. Apart from his strange antipathy for sheep, this horse (a gelding of about seven or eight years old) is a quiet, good-tempered, tractable animal. As is well known, many mares running with their foals show great dislike to dogs, and the same may be said of cows, ewes, and sows when their respective offspring are young. The close affinity between wolf and dog, however, seems sufficient to account for this. But that the sight of an inoffensive herbivorous animal of comparatively small size should have the effect of exciting the rage of an otherwise amiable and well-conducted horse is hard to understand.—G. T. Rope (Blaxhall, Suffolk).

Additional Notes on Mus flavicollis, Melch.—On Oct. 21st last I trapped a fine female of *Mus flavicollis* in a house cupboard set apart for household stores. The invading of man's habitation (*ante*, p. 243) by this mouse is not without significance, and tends to urge a still further claim for its establishment as a good species. True it is that there are many reports on record of *M. sylvaticus* being taken in houses. Many such reports have been conveyed to me, but on careful investigation all the captures reported were *flavicollis*, and not *sylvaticus*, though without doubt *sylvaticus* does occur at times in houses. Should anyone sufficiently interested in the matter of the house-loving proclivities of *flavicollis* wish to investigate the truth of this, let him lay down a few traps where potatoes or other "root" vegetables have been stored in a cellar, and should *flavicollis* occur in his neighbourhood he is almost certain to trap it there. It may be that in course of time our domiciles will produce a fine and large species of house-mouse evolved from descendants of the Yellow-necked Field-Mouse. It is said, and probably with truth, that the House-mouse (*Mus musculus*) originally came from Asia, and in course of time spread its way throughout the world wherever man has gone. This mouse under various climatic influences has so diverged from the type that its many variations have received specific names, as *Mus gentilis*, Brantz., *M. muralis*, Bar.-Ham., *M. flavescens*, Fisher, &c. On the North Bull, Dublin Bay, there is to be found a house-mouse which, contrary to *M. flavicollis*, has forsaken man's habitation to lead a feral life (Journ. Linn. Soc., Zool., vol. xxvi. pp. 465, 473). In the directions given to numerous collectors of natural history specimens, all small mammals are wanted *except* those taken in houses. If, as we see to be the case in our British field-mice, other species take to a semi-domestic life, it wlll behove the collector of the future to give his attention as much to the house as to the field whilst engaged in trapping small mammals. I have in my possession a *M. musculus* mouse, which I took in a farm-building, so remarkable in colour—a bright yellowish fawn—that had it been taken abroad would certainly have led to a suspicion of its being a new species. The measurements of the house-trapped *flavicollis* mentioned above were: Head and body, 100 mm.; tail, 111 mm.; hind foot, 12 mm.; ear, 14 mm.—Gordon Dalgliesh (Midhurst, Sussex).

Intelligence of a Squirrel.—Referring to Mr. Dodsworth's article (*ante*, p. 361) on "Mental Powers of Animals," I may mention that in 1908, when passing a group of pine-trees in Bingley Wood, one of which contained a nest which could not have been long built, and thinking possibly it might be a Squirrel's drey, I gave the bole of the tree a vigorous kick, and afterwards I took hold of the tree with both hands and gave it a most violent shake, when in a few moments a Squirrel fell almost at my feet in a state of trepidation. Both of us for some moments were facing each other and motionless, after which I made a pretence of seizing it, but never for a moment thought of touching the animal, since I remember very well a person in North Yorkshire who once seized one under similar circumstances, and was bitten in a most vicious manner. The Squirrel no sooner saw me spring towards it than it made for a birch-tree forming part of a group which thinned out and ended in a solitary tree on a heath. I followed close after, shaking the trees in its rear, thus forcing it forward towards the solitary tree. This I did with success until the Squirrel was nearing the tree in question, when it at once appeared to realize its position. It took but some moments to grasp the situation, when it determined to make back to the pine-trees; this, however, I prevented by severely shaking the birch-trees, but do as I would the Squirrel would not be forced to the solitary tree, and when I bent down to pick up a piece of peat to throw, the effect of which, I thought, would force it into the isolated position, it took advantage of this psychological moment to return to the clump of pine-trees from which it had been driven.—E. P. BUTTERFIELD (Wilsden).

P.S.—*Correction.*—On page 396 (*ante*), for *tywort* flowers read *figwort* flowers. This error occurs fourteen lines from bottom of page.—E. P. B.

Yawning of Rodents.—I have a White Rat (*Mus rattus*) which I have often observed yawning.—ELIZABETH RUSSELL (16, Beaufort Gardens, S.W.).

AVES.

Kestrel and Starlings. — Although the following circumstance may have no real connection with Mr. Butterfield's experience (*ante*, p. 392), it has perhaps some interest of its own. On Oct. 19th of last year, near Havering, in Essex, I watched an adult male Kestrel harassing a flock of between two and three hundred Starlings. The latter birds were on the wing, and packed into an extraordinarily dense mass; they manœuvred in perfect silence, and appeared perfectly self-possessed and free from panic. The hawk was flying above and slightly behind the flock, and whenever a Starling became separated by a foot or so from its companions he made a vicious plunge at the isolated bird. This happened several times, and in each case the threatened Starling uttered a short note of alarm and turned into the ranks of the main body, while the hawk took up its former position. The flock drifted in an aimless course across the fields, accompanied by the vigilant and determined enemy, until each became invisible against the dark background of a distant wood. In less than a minute the Starlings returned, settled amongst a herd of cattle, and commenced to feed as though nothing out of the ordinary had occurred. I never saw the Kestrel again, and did not learn that any of its attempts had succeeded. In districts where the smaller Mammalia are scarce, and where the absence or scarcity of trees or bushes favours the operations of hawks, such birds as Redwings and Thrushes form the staple food of the Kestrel, and I am inclined to believe that such large birds as Mistle-Thrushes or Fieldfares are taken, for I have often found the feathers of the latter birds at times and in places that suggested the work of the Kestrel and not the Sparrow-Hawk. I have seen the two smaller species pursued and killed by Kestrels on many occasions. At the end of July, on the moors near Selborne, in Hampshire, I found the remains of a full-grown young Cuckoo under circumstances that left little room for doubt that the slayer had been a bird of prey and not a mammal. Cuckoos, one would imagine, ought to be rather free from the attentions of hawks. —Fredk. J. Stubbs.

Rare American Teal in Co. Cork.—On Sept. 9th a fine specimen of a female American Blue-winged Teal was shot near Rostellan by Mr. B. Wise, of Maryland. It was exhibited at the meeting of the British Ornithologists' Club on October 17th, but, though agreeing as to the identity of the bird, a doubt was cast on its being a wild-reared bird, because Blue-winged Teal had been bred at Winslow, although no one had heard of any escapes from that collection. It might thus appear that the Club has come to the conclusion that no rare bird obtained in future will be looked on, without doubt, as a wild visitor while any of the same species are kept in captivity.—Robert Warren (Ardnaree, Monkstown, Co. Cork).

AVICULTURE.

The Crossbill in Captivity.—'The Zoologist' for 1906 (p. 189) contains a few notes of mine on a tame Crossbill in our possession. We succeeded in keeping him till October 31st last, when he died. I noticed that for a week or two previously he seemed to lose strength, and to be unable to pull his fir-cones to pieces, but he fed well on seed to the last. He had certainly been caged for more than six years, and possibly longer, as when I first saw him in July, 1904, he was in mature yellow-green plumage. Two days after we lost him I saw another in a bird-shop in Ipswich, which was said to have come over from Belgium, and brought him home. The new-comer is at present in perfect health and plumage (yellow-green, like the other), and if he affords us half the pleasure and amusement we derived from our lost pet "Gyp," I shall not regret the investment. During the great immigration of Crossbills last winter I had several opportunities of watching these birds feeding here on larches, and it is most interesting to see the same quaint attitudes in a tame bird, for no bird becomes more familiar in confinement than the Crossbill, or more ready to respond to kindness and attention.—Julian G. Tuck (Tostock Rectory, Bury St. Edmunds, Suffolk).

NOTICES OF NEW BOOKS.

Reptiles of the World. By Raymond L. Ditmars. Sir Isaac Pitman & Sons, Ltd.

A description of the reptiles at present found living on this planet is practically but a roll-call of survivors of the great reptilian era before the domination of *Homo*; to understand what that reptilian fauna was like when in its pride of place, the palæontologist must be consulted. We cannot ascribe the fall of this vast reptilian fauna to the sole action of man, though his hand falls heavy on the existing representatives of to-day. Thus we are again told of the Hawk's-Bill Turtle, continually hunted for the "tortoise"-shell obtained from its carapace. "The shields are removed from the shell by heating it, when they commence to peel, and are assisted in the process by the operator. As the operation often involves a living reptile, the martyred creature is turned loose afterwards, for the belief is hat it grows a new coat of shields." The Diamond-Back Terrapin (*Malacoclemmys palustris*), "one of the requisites in making up a champagne dinner, and consequently a valuable and well-known market delicacy," has a market demand that we read "threatens early extinction." The Tuatera was in comparatively recent years abundant on the larger islands of New Zealand. Diminished by various causes, "they are diligently hunted for scientific institutions, and not many years will pass before the last Tuatera to remain in the flesh will repose within a museum jar." It should be here mentioned that Mr. Ditmars in this book, though following in the main Dr. Boulenger's system of classification, popularly divides the Chelonians into three groups:—

Tortoises.—The strictly terrestrial species.

Turtles.—The semi-aquatic and marine species.

Terrapins.—Those hard-shelled, fresh-water species that are edible and have a recognized market value.

A great deal of personal observation by the author himself is recorded in these pages, and this not only derived from captives in the New York Zoological Park, but also from many of the creatures in their natural haunts. There is also very much valuable advice as to the treatment of reptiles in captivity, a subject of much difficulty, as most of us will bear witness who have travelled and endeavoured to keep these creatures. A coloured frontispiece and nearly two hundred illustrations from photographs taken by the author are not only a great assistance to the student, but give us the individuality of each species as only photography can disclose.

Mr. Ditmars has some pertinent remarks on the phenomenon of change of coloration in certain Lizards :—

> "It is a mistake to imagine the colour changes to be strictly in line of protection to the lizard in immediately conforming to the colours of surfaces on which the animal rests. A specimen capable of exhibiting all phases of coloration between a dull brown to an emerald-green may for some time rest upon a dead tree-trunk, and be clad in a suit of conspicuous steel-grey; from this hue it may transform into a livid green; a few minutes later it may jump among the leaves and shrubbery, where it takes on an almost blackish hue . . . Who can blame certain romantic authors for elaborating upon such an admirable point as the 'power' displayed by a dull brown lizard to jump upon a leaf and transform into a leafy green, thence upon a tree-trunk, where it immediately turns brown again, and from there, possibly, upon a gorgeous flower, where the reptile assumes a hue to match the richly-coloured petals?"

We notice that Mr. Ditmars, as regards the King Cobra, or Snake-eating Cobra (*Naja bungarus* = *Ophiophagus elaps*), states that it attains the great length, for a poisonous snake, of twelve feet. The writer of this notice, however, more than forty years ago, obtained and skinned a specimen in the Malay Peninsula which was afterwards identified and measured by Dr. Günther. Its length was 13 ft. 2 in. (*cf.* Zool. 1875, p. 4625).

A Monograph of the British Nudibranchiate Mollusca. Part VIII. (Supplementary). Figures by the late Joshua Alder and Albany Hancock, and others. Text by Sir Charles Eliot, M.A., D.C.L., &c. Ray Society.

This Supplement to the 'Monograph on the British Nudibranchiata,' by Alder and Hancock, will be welcomed by all naturalists, whilst the introductory sections give probably the best general account of these creatures which has yet been written. We refer more particularly to this portion of the publication because it can be read with interest and profit by all zoologists, even if they possess no special knowledge themselves of the Nudibranchiate Mollusca. It embraces such subjects as Variation and Distribution, Bionomics, Embryology and Larval Stage, and Anatomy. In present speculative and theoretical suggestions—and they are valuable and stimulating—such records as these, referring to animal life not usually dealt with in evolutionary discussions, are of the very utmost importance, and will be found to be both qualitative and confirmatory on many disputed views.

Colour variation appears to be most striking in Nudibranchs. The range of colours comprises red, yellow, pink, brown, and grey of many shades, purple, slatey-blue, sage-green, and perhaps others. "In a series of specimens received from the Isle of Man slate-colour and greyish-blue predominate. At Plymouth red and yellow, though not universal, are very common. . . . . At Plymouth many marine animals as well as seaweeds are reddish." Both adult and young Nudibranchs appear and disappear suddenly in considerable quantities, especially before spawning and after hatching. Alder and Hancock were disposed to disbelieve in these migrations, but Sir Charles Eliot considers "there is a good deal of evidence for their occurrence. It is not known how they are performed, but as creeping is an extremely slow process, it is possible that the animals make use of currents in which to suspend themselves." As regards protective resemblance, Nudibranchs frequently escape notice because their colour and to some extent their shape fit in with their surroundings, and, as Sir Charles Eliot remarks, "Of the reality of this phenomenon no one can doubt who has collected them in the tropics." But he also qualifies some suggestions on this subject. He says :—

> "These resemblances are striking, and clearly cannot be disadvantageous to the molluscs, but still I think that much of the language used about protective coloration, as if the animals were made to look like their surroundings by some special power either in themselves or external, is too anthropomorphic. It underestimates the importance of one commonplace factor in the situation, namely, that the two objects which resemble one another (such as the Nudi-

> branch and the sponge or seaweed) have been associated and exposed to the same influences for unnumbered ages. Thus, whatever may be the causes which tend to give a sponge a certain appearance, they must also affect the Dorid which lives on the sponge, at least so far as they are external and concerned with water, temperature, and general surroundings."

In a footnote it also stated—

> "that not only do Dorids resemble sponges (where the resemblance is advantageous to the Dorids), but also sponges resemble Dorids (where no such advantage to the sponge is clear)."

We are still in the wood of speculation!

There is as an appendix a useful bibliography of books and papers dealing with the Nudibranchiata of the Atlantic (including the Mediterranean and Caribbean Seas), which have been published since the completion of Alder and Hancock's Monograph in 1855, and there are eight beautifully coloured plates.

A History of British Mammals. By GERALD E. H. BARRETT-HAMILTON, B.A., F.Z.S., &c. Gurney & Jackson.

THE first part of Barrett-Hamilton's British Mammals has now appeared; it has been much anticipated, and, we are told, "its author has had its production before him for over twenty years." It is announced that the work will consist of three sections, dealing respectively with the Bats, the Land Mammals, and the Marine Mammals.

It is impossible to give from this part alone any adequate notice of the publication, as even the General Introduction to Bats is unfinished, and announced to be completed in parts ii. to vi. No one, however, can miss the recognition of its thoroughness in treatment and its wealth in reference. We must await the completion of a section before attempting to more fully review it.

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